



Final Report

Reporting Period: October 1, 2013 through September 30, 2016

Award Number: P2-NP-96323701-0

Project Title: Establishing P2E2 Best Practices and Performance for Pennsylvania Small to Mid-Size Businesses

Recipient Organization: Pennsylvania Department of Environmental Protection (PADEP)
Office of Pollution Prevention and Energy Assistance
Rachel Carson State Office Building
400 Market Street 1 2nd Floor
Harrisburg, PA 17105

PADEP Principal Investigator: Libby Dodson, Manager; 717-772-8907; libdodson@pa.gov

Partner: Pennsylvania Technical Assistance Program (PennTAP)

PennTAP Principal Investigator: Tanna Pugh, Director; 814-865-0427; tannapugh@psu.edu

PennTAP Project Manager: Roger Price, 412-889-5821; rlp20@psu.edu

EPA Project Officer: Mindy LeMoine, 215-814-2736; lemoine.mindy@epa.gov

TABLE OF CONTENTS

1. Project Objective.....	2
2. Project Background.....	2
3. Outcomes from Previous P2E2 and E3 Grant Projects That Were Verified During This Reporting Period.....	2
4. Executive Summary of This Grant Project's Activities and Outcomes.....	3
5. Outreach Activities.....	4
6. Webinar.....	7
7. P2E2 Assessment Activities and Status.....	8
8. Client Comments.....	9
9. Penn State University Student Engagement Activities.....	10
10. Outcomes Details.....	12
11. Historic Summary of PennTAP P2E2 and E3 Assessment Program Outcomes...	17



1. Project Objective:

The core function of the Pennsylvania Department of Environmental Protection's (PADEP) Office of Pollution Prevention and Energy Assistance (OPPEA) is the promotion of pollution prevention (P2) and energy efficiency (E2) initiatives. OPPEA achieves its objectives through various programs that have demonstrated notable successes. In partnership with the Pennsylvania Technical Assistance Program (PennTAP) at Penn State University, this project advanced OPPEA's core function through technology assistance to businesses that addresses the reduction of energy usage or the elimination of pollution across all environmental media with an emphasis on methanol and other solvents.

2. Project Background:

This project delivered a comprehensive set of activities to establish current P2E2 best practices in Pennsylvania. The initial target market for these activities was methanol and solvent waste generators, however all small to mid-sized manufacturers in Pennsylvania were eligible. The activities also implemented the new P2E2 best practices and incorporated student education.

3. Outcomes From Previous P2E2 and E3 Grant Projects That Were Verified During This Reporting Period:

The PennTAP-PADEP partnership has been successfully assisting businesses with investments from the U.S. Environmental Protection Agency's (EPA's) P2 Grant Programs since 2000. We determine and report the outcomes (lbs. waste reduced, bBtu energy conserved, etc.) that result from grants that we receive from the EPA by periodically returning to clients to verify actual implementation of P2E2 and Economy, Energy, and Environment (E3) recommendations. Some recommendations are not implemented until several years after the assessment is completed. For this reason, it is PennTAP's practice to re-survey our clients to identify new project implementation outcomes for as many as five years after the assessment is completed. Consequently, since the duration of EPA-funded grants is typically two years or less, some assessment project outcomes are not verified until after the EPA-funded grant project is closed. We believe that it is important for the agency to capture this information as it is further evidence of the value and success of EPA's on-going P2 Grant Programs. For this reason, we chose to include in this report the following outcomes from assessments that were completed previously and that were funded by previously closed grant projects but that were not verified until this reporting period. Outcome details from previous grant projects are provided in Section 10.



Table 1: Outcomes From Previous/Other P2E2 and E3 Grant Projects That Were Verified During The 6-Month Reporting Period 4/1/2016 to 9/30/2016

Measurement Type	Notes	Units	Outcomes
Hazardous waste reduced	1	lbs/yr.	0
Non-hazardous waste reduced	1	lbs/yr.	0
Water conserved	1	Gal/yr.	0
Direct air emissions reduced	1	lbs/yr.	76,000
Indirect air emissions reduced	1	lbs/yr.	120,000
Carbon Dioxide Equivalent (CO _{2eq}) reduced	2	Metric tons/yr.	90
Millions of British thermal unit (BTU) of other energy conserved (incl. gas +diesel fuel + coal + etc.; not incl. MW-h)	3	MMBTU/yr.	650
Megawatt hours (MW-h) of primary electric energy conserved	4	MW-h	100
Billions of British thermal unit (BTU) of total energy conserved (includes other + electric)	5	BBTU	1.0
Dollars (\$) saved through P2E2 efforts	1	\$	\$6,000
1. Determined by follow-up client contact to verify actual implementation of assessment recommendations.			
2. $MTCO_{2eq} = \text{Primary } MTCO_{2eq} = \text{Primary CO}_2 \text{ lbs.}/2205$; $\text{Primary CO}_2 \text{ lbs.} = (\text{Fence Line kWh} \times 3.1 \times 1.234 \text{ lbs. CO}_2/\text{kWh}) + (\text{MCF} \times 1.02 \text{ MMBTU}/\text{MCF} \times 117 \text{ lbs. CO}_2/\text{MMBTU})$			
3. $\text{Other MMBTU} = \text{Other (gas + diesel fuel + coal + etc.) BTU} \text{ divided by } 1,000,000$			
4. $\text{Primary MW-h} = \text{Primary kWh} \text{ divided by } 1,000$; $\text{Primary kWh} = 3.1 \times \text{Fence Line kWh}$			
5. $\text{Total BBTU} = \text{Primary MMBTU} \text{ divided by } 1,000$; $\text{Primary MMBTU} = \text{Other MMBTU} + \text{Primary MW-h} \times 3.413 \text{ MMBTU}/\text{MW-h}$			

4. Executive Summary of This Grant Project's Activities and Outcomes:

Under the current grant project, PennTAP has met or exceeded, often significantly, the activity goals established in the grant. These activities are quantified in Table 2 below. In addition, the assistance PennTAP provided to Pennsylvania businesses under the current grant resulted in substantial reductions in air pollutant emissions and other environmental benefits. These outcomes are summarized in Table 3.

Table 2: EXECUTIVE SUMMARY Of This Grant Project's Activities

Activity Description	Metric Unit	3-Yr Project Goals	2.5 -Year	6 th Six Months	Total 3 -Year
			10/1/2013-3/31/2016	4/1/2016-9/30/2016	10/1/2013-9/30/2016
P2/E2 Assessments	# of assessments	35	28	8	36
Businesses provided with P2/E2 information	# of businesses	100	151	55	206
Students engaged in program activities	# of students	15	80	4	84
P2/E2 Webinars or Tools	# of events	2	2	0	2
P2/E2 success stories	# of stories	3	0	3	3



Table 3: EXECUTIVE SUMMARY Of This Grant Project's Outcomes

Measurement Type	Notes	Units	3-Yr Project Goals	2.5 -Year	6 th Six Months	Total 3 -Year
				10/1/2013-3/31/2016	4/1/2016-9/30/2016	10/1/2013-9/30/2016
Hazardous waste reduced	1	lbs/yr.	17,500	0	0	0
Non-hazardous waste reduced	1	lbs/yr.	8,750	0	0	0
Water conserved	1	Gal/yr.	65,625	0	0	0
Direct air emissions reduced	1	lbs/yr.	87,500	0	135,000	135,000
Indirect air emissions reduced	1	lbs/yr.	65,250	57,900	1,536,100	1,594,000
Carbon Dioxide Equivalent (CO _{2eq}) reduced	2	Metric tons/yr.	131,250	26	750	776
Millions of British thermal unit (BTU) of other energy conserved (incl. gas +diesel fuel + coal + etc.; not incl. MW-h)	3	MMBTU/yr.	43,750	0	1,150	1,150
Megawatt hours (MW-h) of primary electric energy conserved	4	MW-h	1,400	47	1,233	1,280
Billions of British thermal unit (BTU) of total energy conserved (includes other + electric)	5	BBTU	49	0.16	5.34	5.5
Dollars (\$) saved through P2E2 efforts	1	\$	\$350,000	\$1,300	\$36,100	\$37,400
1. Determined by follow-up client contact to verify actual implementation of assessment recommendations.						
2. $MTCO_{2eq} = \text{Primary } MTCO_{2eq} = \text{Primary CO}_2 \text{ lbs.}/2205$; $\text{Primary CO}_2 \text{ lbs.} = (\text{Fence Line kWh} \times 3.1 \times 1.234 \text{ lbs. CO}_2/\text{kWh}) + (\text{MCF} \times 1.02 \text{ MMBTU}/\text{MCF} \times 117 \text{ lbs. CO}_2/\text{MMBTU})$						
3. $\text{Other MMBTU} = \text{Other (gas + diesel fuel + coal + etc.) BTU divided by } 1,000,000$						
4. $\text{Primary MW-h} = \text{Primary kWh divided by } 1,000$; $\text{Primary kWh} = 3.1 \times \text{Fence Line kWh}$						
5. $\text{Total BBTU} = \text{Primary MMBTU divided by } 1,000$; $\text{Primary MMBTU} = \text{Other MMBTU} + \text{Primary MW-h} \times 3.413 \text{ MMBTU}/\text{MW-h}$						

Note that outcome details from this grant project are provided in Section 10.

5. Outreach Activities:

PennTAP's outreach efforts have been successful in promoting energy efficiency and pollution prevention in the region. The following provides a summary of those outreach activities conducted throughout the grant period.

Presentations, Seminars, and Network Building Activities

- Provided input for an article in the Northwest Pennsylvania Industrial Resource Center (NWIRC) Monthly Newsletter regarding NWIRC Energy events scheduled for March and April. Copies of the event announcements are provided in the attachments to this report.
- Participated with a PennTAP Student Intern in the Pittsburgh Region Association of Energy Engineers (AEE) meeting on "Industrial/Commercial HVAC Chilled Water Plant Energy Optimization".
- Participated in the Beaver County and Southwest Pennsylvania Manufacturing Community Roundtable.
- Presented information on PennTAP's E3, PPIS P2E2 and ISO 50001 assessment programs at NWIRC's Lunch and Learn event in Erie, PA.



- Prepared the presentation and presented the National Pollution Prevention Roundtable (NPPR) Webinar on Successful Grant Writing and Reporting. Topic: “Effective Approach to Collecting and Reporting Metrics – PennTAP’s Perspective.”
- Participated in a meeting with Dana Gordon, Business Advisor for the Innovative Manufacturers’ Center (IMC). Dana is actively working to help recruit companies for E3, PPIS P2E2 and ISO 50001 assessment projects.
- At the Penn State Learning Factory Expo booth for the student research project to develop a compressed air leak detection tool, met with Brandon Myers, Foundry Process Engineer for the Anvil International Columbia Plant, and received an invitation to visit the facility in order to meet with the facility environmental engineer and other facility managers for discussions on PennTAP services including student engagement activities, ISO 50001, P2E2 assessments and OSHA technical assistance.
- Prepared and presented updated information on PennTAP services at a meeting of the NWIRC regional field representatives.
- Wrote success story entitled “Penn State Engineering Students Excel in Conducting Industrial Pollution Prevention and Energy Efficiency Assessments” and provided it to the Pacific Northwest Pollution Prevention Resource Center (PPRC) at their request for inclusion in a 25-year retrospective report.
- Participated in the annual EPA and State P2 Programs Dialogue Meeting at EPA Headquarters in Washington D.C. and presented information on PennTAP’s P2E2 programs.
- The PennTAP team marketed P2E2 assessments to PennTAP clients in the Team Information Management System (TIMS) master e-mail list. The PennTAP Technical Advisors did one-on-one marketing efforts with companies by email and phone.
- PennTAP’s E3, PPIS P2E2 and ISO 50001 assessment programs were promoted by our Industrial Resource Center (IRC) partners, the NWIRC and the IMC.

Outreach Flyers and Newsletters

- PennTAP’s Quarterly Newsletters included articles regarding our P2E2 assessment accomplishments and services.
- A one-page outreach flyer describing the P2E2 assessment services was prepared and distributed. A copy is provided in the attachment to this report.
- PennTAP’s P2E2 assessment services were promoted through PennTAP’s website: <http://penntap.psu.edu/energy-environment/pollution-prevention-energy-efficiency/>



Press Releases

- “Student Engagement Performing Energy Efficiency Assessment for Kurtz Bros.” WJAC-TV and WTAJ-TV both did stories on a PennTAP program that takes students out of the classroom for energy audits.
- Outreach Marketing Office PennTAP engaged scholarship video. This video has been approved by PSU’s central University Marketing office. <http://youtu.be/t2QIuUBuhNI>
- “Businesses Work with Students and PennTAP to Assess Energy Usage” (*Clearfield Progress*) Posted 22 July 2014
- “Businesses Work with Students” (*Centre County Gazette*) Posted 22 July 2014
- “Businesses Work with Students” (*Gantdaily*) Posted 10 July 2014
Executives at Kurtz Bros. in Clearfield have built a strong relationship over time with the Pennsylvania Technical Assistance Program (PennTAP). The school supplies, equipment and furniture distributor recently opened its doors to a group of students who conducted an energy audit of the facility.
- “Businesses Work with Students, PennTAP to Assess Energy Usage in Facilities” (*Penn State News*) Posted 7 July 2014
Executives at Kurtz Brothers in Clearfield have built a strong relationship over time with the Pennsylvania Technical Assistance Program (PennTAP). The school supplies, equipment and furniture distributor recently opened its doors to a group of students who conducted an energy audit of the facility.

6. Webinar:

The first of two P2E2 webinars was conducted on Thursday, August 20, 2015, and the second on October 15, 2015 (See attached webinar announcement). The webinar provided a review of the process for completing a Pollution Prevention and Energy Efficiency facility assessment and results of successful P2E2 assessment projects. The webinar presentation is attached. The webinar was recorded and stored on the PennTAP website at <http://penntap.psu.edu/events/>.



7. P2E2 Assessment Activities and Status

During the current grant period, PennTAP has performed P2E2 assessments for Pennsylvania manufacturers in a variety of industries spread across 21 different counties. Further details about the assessments and their respective statuses are presented in Table 4.

Table 4: P2E2 Assessment Activities and Status			
Project ID	Business Description	County	Quarter Completed
RLP-13-031	Metal Products	Elk	4Q13
RLP-13-032	Metal Products	Somerset	4Q13
RLP-14-002	Petroleum Products	McKean	1Q14
RLP-14-005	Wood Products	Clinton	1Q14
RLP-14-006	Transportation Products	Lycoming	1Q14
RLP-14-008	Printing	Clearfield	1Q14
RLP-14-009	Wood Products	Jefferson	1Q14
RLP-14-018	Chemical Products	Clinton	4Q14
RLP-14-021	Petroleum Products	Erie	4Q14
RLP-14-012	Chemical Products	Clinton	1Q15
RLP-14-023	Plastic Products	Huntingdon	3Q15
RLP-15-011	Metal Products	Beaver	3Q15
RFS-15-003	Metal Products – Man Lifts	Fulton	4Q15
RFS-15-004	Metal Products – Man Lifts	Bedford	4Q15
RFS-15-006	Plastics Injection Molder	Snyder	4Q15
RWJ-15-010	Plastics Injection Molder	Somerset	4Q15
RLP-15-015	Metal Products	Clearfield	4Q15
RLP-15-013	Adv. Material and Diver. Mfg.	Erie	4Q15
RLP-15-012	Block and Brick Manuf.	Erie	4Q15
RFS-15-011	Printing	Clearfield	1Q16
RFS-16-006	Chem., Rubber, and Plastics	Huntingdon	1Q16
RWJ-16-001	Adv. Material and Diver. Mfg.	Center	1Q16
RWJ-16-005	Manufacturing	Union	1Q16
RLP-16-002	Industrial Equip. Manuf.	Crawford	1Q16
RLP-16-001	Refractories	Erie	1Q16
RFS-16-004	Wood Products	Jefferson	1Q16
RFS-16-005	Metal Products – Man Lifts	Bedford	1Q16
RWJ-16-004	Adv. Material and Diver. Mfg.	Blair	1Q16
RWJ-15-015	Manufacturing	Union	1Q16
RWJ-16-006	Road Equipment	Clarion	1Q16
RWJ-16-007	Concrete Panels	Snyder	2Q16
RWJ-16-008	Food Processing	Snyder	2Q16
RFS-16-016	Metal Products	Berks	2Q16
RFS-16-015	Materials Testing	Elk	2Q16
RLP-16-004	Food Processing	Westmoreland	3Q16
RLP-16-005	Food Processing	Westmoreland	3Q16



8. Client Comments:

The following are some examples of client comments.

“I was impressed with your report and felt the information was exactly what I needed.” *Lon Sippy at Highpoint Tool*

“Thanks for providing this, there is a lot of great information here.” *Jared Sayers of PAFC Linesville Fish Hatchery*

“It was a very detailed look at the usage of electricity. Some very interesting ideas that we have not thought about before. Small businesses will benefit from having this sort of audit.” *Patrick Hanlon, DiamondBack Truck Covers*

“Very helpful putting together the information that we need to make a financial decision. So many times, at smaller manufacturing sites, we don't often have the manpower available to look for the cost savings project we know must be there. This is a great first step.” *Kyle Frank, Vice President, Huntingdon Fiberglass Products*

“I could not have completed the grant process without the help from Roger Price. Roger did a site evaluation and advised me on a HVAC upgrade plan that would save Doult Tool Inc. an estimated \$5,000.00 per year in electric costs. The lower operating costs will translate into more money for the Corporation to reinvest in new technology and training to compete in the global marketplace. Every manufacturing business in Pennsylvania could benefit from Roger's experience” *Robert Melvin, President, Doult Tool*

“Roger, just wanted to let you know that we did receive the DEP grant. Thank you all for your assistance in the grant process. I will be sharing information about both grants and your program with other maple producers at the Lake Erie Maple Expo and Conference in November. I will also be doing a short presentation at the PA Maple Producers Fall Tour as well as the Northwest PA Maple Producers Annual meeting. Hopefully, this will stir up some additional interest in these grant opportunities. It is your program's assistance that removes the biggest drawback to these grants, which is the actual application process. Thanks again.” *Gary Bilek, Owner, Triple Creek Maple*

“Great crew, worked well with our group with no interruptions to production. Realized cost savings by correcting areas identified in the final report.” *Al Wassel, President, PSB Industries*

“This is a large project for us 100K-130K - needless to say, a time consuming project that resulted in a lot of diverse possible solutions. With Roger's information we obtained three quotes to compare and might as well have been comparing an apple, orange, and a banana. It was nice to have someone in our corner that was knowledgeable in this category. We would probably still be analyzing data if it had not been for Roger. Lighting sounds straight forward but we quickly learned that it is anything but. Roger and his team was able to work with us further so that we understood what our choices were and the ramifications of each. I am sure I have underestimated the cost savings we received.” *Trish Stewart of Triangle Suspension Systems*



9. Penn State University Student Engagement Activities:

One objective of this program is to engage Penn State University engineering students in performing P2E2 assessments at industrial facilities in order for the student to learn about and embrace a proactive, economically responsible energy and environmental conservation ethic that is sustainable.

Table 5: PennTAP Student Engagement P2E2 Assessments	
Business Description	County
Powdered Metal Products	Elk
Transportation Equipment Manufacturer	Lycoming
Printer	Clearfield
Manufacturer Of Powdered Metal	Cambria
Wood Products	Clinton

The following seven activities were conducted during this reporting period with Penn State University engineering student involvement – a total of 437 hours of student time engaged.

With five students from the EGEE 494A class, a compressed air system energy efficiency assessment was performed for a powdered metal products manufacturer located in St. Marys.



With five students from the EGEE 494A class, a compressed air system energy efficiency assessment was performed for manufacturer of powdered metal located in Johnstown.

With one student intern, we participated in the Pittsburgh Region AEE meeting on “Industrial/Commercial HVAC Chilled Water Plant Energy Optimization”.



With five students from the EGEE 494A class, a building envelope energy efficiency assessment using infrared cameras was performed for a transportation equipment manufacturer located in Williamsport.

With three student interns and five students from the EGEE 494A class, an energy efficiency assessment of selected facility motors was performed for a wood products manufacturer located in Mill Hall by installing recording electric power analyzers on four of the facilities largest motors.



With five students from the EGEE 494A class, a compressed air system energy efficiency assessment was performed for a printer located in Clearfield.

With two PennTAP Engineering Student interns, we assisted eight clients that were winners of a PADEP Small Business Advantage Grant (SBAG) to get registered to the EPA Energy Star Portfolio Manager.





10. Outcomes Details:

The following tables provide detailed information for the outcomes reported previously in Sections 3 and 4. Both direct emissions (on-site combustion, fugitive emissions, etc.) and indirect emissions (power plant emissions due to on-site electric power consumption) are reported, along with the CO₂, NO_x, SO_x, PM₁₀, VOC, CO, and HAP pollutant components of those emissions. CO₂-equivalents were calculated from both the primary electric power consumption (kWh/yr.) and from the direct emissions due to on-site combustion. Also provided are the activities contributing to CO₂-equivalents reduction and the emission factors used for these calculations.



**Table 6: Details of Outcomes From Previous/Other P2E2 and E3 Grant Projects
That Were Verified During The 6-Month Reporting Period 4/1/2016 to 9/30/2016**

RECOMMENDED ACTION				PRIMARY Air Emissions			Solid Wastes		Energy and Natural Resources			Direct and Indirect Air Emissions							Economic Benefits		
<u>System (Sys)</u> ST = Steam PH = Process Heating CA = Compressed Air PU = Pumping MO = Motors FA = Fans OS = Other Systems NE = Not Energy				Indirect	Direct	Metric Tons of CO ₂ Equiv. /yr.	Non-Hazardous	Hazardous	Water Consumed	Primary Electric Power	Other (e.g., nat. gas; diesel; coal)	CO ₂	NO _x	SO _x	PM ₁₀	VOC	CO	HAP	Annual Cost Savings	Implementation Cost	Payback
C o	Short Title	Sy s		lb./yr.	lb./yr.	MTCO ₂ e/ yr.	lb./ yr.	lb./ yr.	gal/ yr.	kWh/yr.	MMB TU/yr.	lb./yr.	lb./yr.	lb./yr.	lb./ yr.	lb./ yr.	lb./ yr.	lb./ yr.	\$/yr.	\$	Yrs
PAFCL	Lighting Upgrade - LFL option	OS	I	81,148		36.5	0	0	0	65,100	0	25,914	57	200	2.6	0.4	2.58	0	\$1,600	\$12,500	7.8
	Boiler Upgrade	PH	D		75,868	33.6	0	0	0		647	75,751	97	0.39	1.2	3.5	16	0	\$3,230	\$37,000	11.5
Fishe	Repair Compressed Air Leaks	CA	I	38,642	0	17	0	0	0	31,000	0	12,340	27	95	1.2	0.2	1.23	0	\$1,000	\$300	0.3
TOTAL ALL				119,790	75,868	87	0	0	0	96100	647	114,005	181	296	5	4	19	0	5830	49800	8.5
NOTES	D = Direct Air Emissions = Emissions from on-site activities such as natural gas combustion in boilers/furnaces, fugitive process emissions, etc.																				
	I = Indirect Air Emissions = Electric power plant emissions due to the facility's electric power consumption																				
	Primary Indirect lb./yr. Air emissions = 3.1(CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO)lb./yr.; “3.1 is the source multiplier used to convert site kWh consumption into the quantity of energy that is consumed at the power plant to generate the kWh consumed at the facility, thereby accounting for power plant combustion and transmission efficiency losses.																				
	Primary Direct lb./yr. Air Emissions = lb./yr. CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO+HAP																				



**Table 7: Details of Outcomes From This Grant Project's Assessments
That Were Verified During The Reporting Period 4/1/2016 to 9/30/2016**

RECOMMENDED ACTION				PRIMARY Air Emissions			Solid Wastes		Energy and Natural Resources			Direct and Indirect Air Emissions							Economic Benefits		
System (Svs) ST = Steam PH = Process Heating CA = Compressed Air PU = Pumping MO = Motors FA = Fans OS = Other Systems NE = Not Energy				Indirect	Direct	Metric Tons of CO ₂ Equiv. /yr.	Non-Hazardous	Hazardous	Water Consumed	Primary Electric Power	Other (e.g., nat. gas; diesd; coal)	CO ₂	NO _x	SO _x	PM ₁₀	VOC	CO	HAP	Annual Cost Savings	Implementation Cost	Payback
C o	Short Title	Sys	D / I																		
HF	Repair Compressed Air Leaks	CA	I	193,210	0	87	0	0	0	155,000	0	61,700	136	476	6.2	0.9	6.15	0	\$3,500	\$600	0.2
KPM	Repair Compressed Air Leaks	CA	I	394,148	0	177.1	0	0	0	316,200	0	125,868	278	972	13	1.8	12.6	0	\$6,000	\$2,000	0.3
	Control Blow-Offs	CA	I	131,383	0	59.0	0	0	0	105,400	0	41,956	93	324	4.2	0.6	4.18	0	\$2,000	\$600	0.3
LE	Weather Stripping and Tank Insulation	OS	I a n d D	2,000	29,500	14	0	0	0	1,600	250	30,000	40	10	1	1	6	0	\$2,000	\$1,000	0.5
NAH	Repair Compressed Air Leaks	CA	I	270,494	0	121.5	0	0	0	217,000	0	86,380	191	667	8.8	1.3	8.61	0	\$4,000	\$1,600	0.4
Koppl	Repair Natural Gas Leaks	OS	D	0	105,536	46.8	0	0	0	0	900	105,372	135	0.54	1.7	4.8	22	0	\$4,100	\$600	0.1
Duchi	Reduce compressed air leaks, pressure	CA	I	146,840	0	66	0	0	0	117,800	0	46,892	103	362	4.8	0.7	4.67	0	\$4,200	\$3,500	0.8
PSB	Reduce compressed air leaks, pressure, use outside air	CA	I	398,013	0	178.8	0	0	0	319,300	0	127,102	280	981	13	1.8	12.7	0	\$10,300	\$4,000	0.4
TOTAL ALL				1,536,000	136,000	750	0	0	0	1,232,300	1,150	625,000	1,260	3,790	52	13	77	0	\$36,000	\$14,000	0.4
NOTES	D = Direct Air Emissions = Emissions from on-site activities such as natural gas combustion in boilers/furnaces, fugitive process emissions, etc.																				
	I = Indirect Air Emissions = Electric power plant emissions due to the facility's electric power consumption																				
	Primary Indirect lb./yr. Air emissions = 3.1(CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO)lb./yr.; "3.1 is the source multiplier used to convert site kWh consumption into the quantity of energy that is consumed at the power plant to generate the kWh consumed at the facility, thereby accounting for power plant combustion and transmission efficiency losses.																				
	Primary Direct lb./vr. Air Emissions = lb./vr. CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO+HAP																				



**Table 8: Details of Outcomes From This Grant Project's Assessments
That Were Verified During The Grant Period 10/1/2013 to 9/30/2016**

RECOMMENDED ACTION				PRIMARY Air Emissions			Solid Wastes		Energy and Natural Resources			Direct and Indirect Air Emissions							Economic Benefits		
System (Sys) ST = Steam PH = Process Heating CA = Compressed Air PU = Pumping MO = Motors FA = Fans OS = Other Systems NE = Not Energy				Indirect	Direct	Metric Tons of CO ₂ Equiv./yr.	Non-Hazardous	Hazardous	Water Consumed	Primary Electric Power	Other (e.g., nat. gas; diesel; coal)	CO ₂	NO _x	SO _x	PM ₁₀	VOC	CO	HAP	Annual Cost Savings	Implementation Cost	Payback
C o	Short Title	Sys	D / I																		
Krtz	Repair Compressed Air Leaks	CA	I	19,321	0	9	0	0	0	15,500	0	6,170	14	48	0.6	0.1	0.62	0	\$500	\$1,000	2.0
P.C.L	Replace V-Belts	MO	I	11,593	0	5	0	0	0	9,300	0	3,702	8	29	0	0	0	0	\$240	\$420	1.8
	Premium E2 Motors	MO	I	27,049	0	12	0	0	0	21,700	0	8,638	19	67	1	0	1	0	\$540	\$7,700	14.3
HF	Repair Compressed Air Leaks	CA	I	193,210	0	87	0	0	0	155,000	0	61,700	136	476	6.2	0.9	6.15	0	\$3,500	\$600	0.2
KPM	Repair Compressed Air Leaks	CA	I	394,148	0	177.1	0	0	0	316,200	0	125,868	278	972	13	1.8	12.6	0	\$6,000	\$2,000	0.3
	Control Blow-Offs	CA	I	131,383	0	59.0	0	0	0	105,400	0	41,956	93	324	4.2	0.6	4.18	0	\$2,000	\$600	0.3
LE	Weather Strip-ping and Tank Insulation	OS	I a n d D	2,000	29,500	14	0	0	0	1,600	250	30,000	40	10	1	1	6	0	\$2,000	\$1,000	0.5
NA	Repair Compressed Air Leaks	CA	I	270,494	0	121.5	0	0	0	217,000	0	86,380	191	667	8.8	1.3	8.61	0	\$4,000	\$1,600	0.4
K	Repair Natural Gas Leaks	OS	D	0	105,536	46.8	0	0	0	0	900	105,372	135	0.54	1.7	4.8	22	0	\$4,100	\$600	0.1
Du	Reduce compressed air leaks, pressure	CA	I	146,840	0	66	0	0	0	117,800	0	46,892	103	362	4.8	0.7	4.67	0	\$4,200	\$3,500	0.8
PSB	Reduce compressed air leaks, pressure, use outside air	CA	I	398,013	0	178.8	0	0	0	319,300	0	127,102	280	981	13	1.8	12.7	0	\$10,300	\$4,000	0.4
TOTAL ALL				1,594,051	135,036	776	0	0	0	1,278,800	1,150	643,780	1,297	3,937	54	13	79	0	\$37,400	\$23,000	0.6
NOTES	D = Direct Air Emissions = Emissions from on-site activities such as natural gas combustion in boilers/furnaces, fugitive process emissions, etc.																				
	I = Indirect Air Emissions = Electric power plant emissions due to the facility's electric power consumption																				
	Primary Indirect lb./yr. Air emissions = 3.1(CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO)lb./yr.; "3.1 is the source multiplier used to convert site kWh consumption into the quantity of energy that is consumed at the power plant to generate the kWh consumed at the facility, thereby accounting for power plant combustion and transmission efficiency losses.																				
	Primary Direct lb./yr. Air Emissions = lb./yr. CO ₂ +NO _x + SO _x + PM ₁₀ +VOC+CO+HAP																				



Table 9: Emissions Factors From Burning Natural Gas and Using Electric Power

CO ₂	NO _x	SO ₂	PM ₁₀	PM _{2.5}	VOC	CO	Units	Fuel Type
2.023	0.004399	0.015705	0.000190	0.000092	0.000027	0.000186	lb./kWh	FF-EGEF
1.234	0.002723	0.009527	0.000125	0.000060	0.000018	0.000123	lb./kWh	All-EGEF
117.080	0.150000	0.000600	0.001860	0.000000	0.005390	0.024000	lb./MMBTU	Natural Gas
119.423	0.153000	0.000610	0.001900	0.000000	0.005500	0.024500	lb./MCF	Natural Gas
FF-EGEF = Fossil Fuel-Based Electricity Generation Emission Factor						MW = 1,000 kW		
All-EGEF = All (total)-Based Electricity Generation Emission Factor						MW = kWh/8,760,000		
1 MCF = 1,000 SCF = 1,020,000 BTU = 1.02MMBTU = 10.2 Therms						1 SCF = 1,020 BTU		
MTCO ₂ e = 0.0542 x MCF Natural Gas					MTCO ₂ e = 0.00056 x kWh electric			
MTCO ₂ e = 0.000034 x gal gas heated hot water conserved					MTCO ₂ e = 0.0000023 x gal cold water conserved			
MTCO ₂ e = 0.000125 x gal electric heated hot water conserved								
Metric Ton Carbon Dioxide Equivalent (MTCO ₂ e) conversions from USEPA Pollution Prevention Program GHG Calculator								

Table 10: MTCO_{2e} Calculations

			Units	lb. CO ₂ Conversion Factor		Source Conversion Factor	lb. CO ₂	lb./MT	MTCO _{2e}
Elec.	FF	1	kWh	2.023	lb. CO ₂ / kWh	3.1	6	2204.6	0.0028
	All	1	kWh	1.234	lb. CO ₂ / kWh	3.1	4	2204.6	0.0017
Nat. Gas		1	MCF	117.080	lb. CO ₂ / MCF	1	117	2204.6	0.0531
		1	MMBTU	119.423	lb. CO ₂ / MMBTU	1	119	2204.6	0.0542
#1, 2 and 4 Fuel Oil		1	Gal	22.494	lb. CO ₂ / Gal	1	22	2204.6	0.0102
		1	MMBTU	160.671	lb. CO ₂ / MMBTU	1	161	2204.6	0.0729
Propane		1	Gal	12.743	lb. CO ₂ / Gal	1	13	2204.6	0.0058
		1	MMBTU	139.116	lb. CO ₂ / MMBTU	1	139	2204.6	0.0631
Metric Ton Carbon Dioxide Equivalent (MTCO _{2e}) conversions from USEPA Pollution Prevention Program GHG Calculator									
Passenger Vehicle Average GHG emissions = 5.5 MTCO _{2e} /yr.									
Source: USEPA, Greenhouse Gas Emissions from a Typical Passenger Vehicle, 2004									
Average Single Family Home Average GHG emissions = 11.3 MTCO _{2e} /yr.									
Source RECS, 2001									



11. Historic Summary of PennTAP P2E2 and E3 Assessment Program Outcomes:

The PennTAP–PADEP partnership has been successfully assisting businesses, with investments from EPA’s Pollution Prevention Grant Programs, since 2000. Over that time, PennTAP has performed nearly 450 P2E2 assessments for Pennsylvania businesses while providing real-world engagement opportunities for approximately 150 students. PennTAP’s efforts have resulted in Commonwealth businesses saving over \$13 million as well as significant reductions in air emissions (including greenhouse gases), water use, solid and hazardous waste, and energy use.

The following table provides a comprehensive historic summary of PennTAP’s P2E2 and E3 program outcomes for the 16-year period from 11/1/2000 through 9/30/2016.

Table 11: HISTORIC SUMMARY Of PennTAP’s P2E2 and E3 Assessment Programs Outcomes for 11/1/2000 thru 9/30/2016			
Measurement Type	Notes	Units	Outcomes
Hazardous waste reduced	1	lbs/yr.	512,000
Non-hazardous waste reduced	1	lbs/yr.	1,800,000
Water conserved	1	Gal/yr.	184,700,000
Direct air emissions reduced	1	lbs/yr.	29,300,000
Indirect air emissions reduced	1	lbs/yr.	205,000,000
Carbon Dioxide Equivalent (CO _{2eq}) reduced	2	Metric tons/yr.	103,000
Millions of British thermal unit (BTU) of other energy conserved (incl. gas +diesel fuel + coal + etc.; not incl. MW-h)	3	MMBTU/yr.	363,000
Megawatt hours (MW-h) of primary electric energy conserved	4	MW-h	185,300
Billions of British thermal unit (BTU) of total energy conserved (includes other + electric)	5	BBTU	995
Dollars (\$) saved through P2E2 efforts	1	\$	\$13,200,000
Dollars (\$) invested in P2E2 efforts implementation	1	\$	\$14,100,000
1. Determined by follow-up client contact to verify actual implementation of assessment recommendations.			
2. $MTCO_{2eq} = \text{Primary } MTCO_{2eq} = \text{Primary CO}_2 \text{ lbs.}/2205$; $\text{Primary CO}_2 \text{ lbs.} = (\text{Fence Line kWh} \times 3.1 \times 1.234 \text{ lbs. CO}_2/\text{kWh}) + (\text{MCF} \times 1.02 \text{ MMBTU}/\text{MCF} \times 117 \text{ lbs. CO}_2/\text{MMBTU})$			
3. $\text{Other MMBTU} = \text{Other (gas + diesel fuel + coal + etc.) BTU} \text{ divided by } 1,000,000$			
4. $\text{Primary MW-h} = \text{Primary kWh} \text{ divided by } 1,000$; $\text{Primary kWh} = 3.1 \times \text{Fence Line kWh}$			
5. $\text{Total BBTU} = \text{Primary MMBTU} \text{ divided by } 1,000$; $\text{Primary MMBTU} = \text{Other MMBTU} + \text{Primary MW-h} \times 3.413 \text{ MMBTU}/\text{MW-h}$			

Table 12: HISTORIC SUMMARY Of PennTAP’s P2E2 and E3 Assessment Program Activities for 11/1/2000 thru 9/30/2016		
Activity Description	Metric Unit	Activities
P2E2 Assessments	# of assessments	444
Business provided with P2/E2 information	# of businesses	7,288
Students engaged in program activities	# of students	148
	# of assessments	150
	# of student hours	17,760